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# Sorghum Tillage
## in the Texas High Plains

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MOST SORGHUM grown in North Texas (Rolling Plains, South Plains and Panhandle regions) is produced on dryland or with limited irrigation. Consequently, water management, both precipitation and supplemental irrigation water, is the most important factor in sorghum production.

Tillage practices can greatly affect soil water content both at planting and during the growing season. For maximum sorghum production and profit, planned crop rotations and tillage practices are critical to enhancing soil water contents and ensuring successful sorghum production. Successful tillage practices are those that:

- Control weeds
- Control erosion
- Reduce evaporation
- Reduce runoff
- Are economical and practical.

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## Tillage Management Tools

Producers can manage sorghum crops by different types of tilling — no-tillage, stubblemulch tillage, reduced and clean tillage.

### No-Tillage

No-tillage management uses chemicals applied with a multi-row sprayer to control weeds, with the only soil disturbance occurring during planting. For establishing a crop, residue cutting coulters or trash whippers (fingers) are often mounted ahead of the double- or single-disc seed openers to cut or move residues away from the seeding area, which improves seed-soil contact. Herbicides for in-season weed control are often banded behind the opener. Starter fertilizer or insecticides can then be applied in or near the seed row. The planting operation is normally accomplished in one pass over the field.

### Stubblemulch Tillage

Stubblemulch tillage has the goal of killing weeds, loosening the soil and maintaining a majority of crop residues on the surface to combat wind erosion and reduce evaporation. Several implements can be used to do this — field cultivators, sweeps or blades and chisels. In the Texas Panhandle, the most common stubblemulch implement is the V-blade plow originated by Noble. These blades, 3-5 feet wide, are operated at a 3- to 5-inch depth, undercutting weed roots and leaving approximately 75 percent of crop residues on the soil surface.

Seeding operations can be performed with most types of planters or drills. A mulch treader with ground-driven, rotating fingers (similar to a sandfighter) can be attached to stubblemulch plows to dislodge weed roots. A disadvantage of stubblemulch tillage is that weeds will often reset if a rain occurs within a day or two after tilling.

### Reduced Tillage

Reduced or minimum tillage uses a combination of stubblemulch tillage and chemicals for weed control and residue management. This method is used by most producers. It takes advantage of the excellent in-season and fallow water-conserving weed control made possible with selected chemicals, and the stubblemulch tilling reduces the cost of weed control and seedbed preparation.

### Clean Tillage

Clean tillage uses disks or moldboard plows to bury crop residues, kill weeds and prepare seedbeds. This traditional tilling system leaves the soil vulnerable to wind and water erosion and results in soil drying from water evaporation and loss to the depth of tillage. It should be avoided if possible. Listing (corrugating to form beds and furrows) is sometimes used in the spring to expose erosion-resistant clods on soils prone to erosion. The practice is prevalent following low residue producing crops, such as cotton, to prevent or reduce wind erosion.

## Weed Control

Whether weed control is mechanical, chemical or a combination, weeds must be controlled while they are small so that soil water is conserved for use by the sorghum. Timely and effective weed control during crop and non-crop (fallow) periods is essential for successful dryland or limited-irrigated crop production.

## Erosion Control

Natural soil formation processes take 30 years or more to form an inch of topsoil. Clean tillage on sloping ground without conservation practices can allow the loss of several inches of topsoil from one high-intensity rainstorm. Using soil conservation practices — terracing, contour rows and furrows, land leveling and waterways — in conjunction with improved tillage and residue management practices can prevent or reduce both wind and water erosion. Improved tillage and residue management practices include no-tillage, reduced- or minimum-tillage and stubblemulch tillage. The primary advantage of leaving some or all of crop residues on the soil surface is to reduce the effect of raindrop impact on the soil surface, which promotes water erosion. To control wind erosion, residues, particularly standing residues, reduce wind energy reaching the soil surface and lessen soil loss.

In practice, tillage (chiseling or listing) is often used to produce a roughened soil surface to control wind erosion following crops such as cotton or sunflower, which produce low amounts of residue. Including sorghum in the crop rotation, in conjunction with improved residue management practices, is an effective method to control both wind and water erosion. The residues improve water infiltration, reduce surface evaporation and reduce both wind and water erosion.

## Reduce Evaporation and Runoff to Improve Water Conservation and Storage

Residues decrease wind speeds and shade the soil surface, which reduce evaporative energy and lessen the ability of water vapor to be removed rapidly from the soil surface. Likewise, residues protect the soil surface from raindrop impact and soil crusting, which keeps the soil surface open and receptive to water infiltration.

Since precipitation and irrigation water must infiltrate the soil surface to become available for plant root uptake, it is advantageous to sorghum production to maintain residues on the soil surface. By doing so, infiltration rates remain high, and the maximum amount of water enters the soil and is moved deeply into the soil profile. Water stored in the root zone below the one-foot depth will normally be available for extraction by roots, even after several months. Water stored near the surface is subject to evaporation.

Tillage with cultivators, sweeps, disks or chisels is a primary method of loosening the soil to destroy soil crusts and enhance infiltration. However, tillage is also largely responsible for much of the evaporation that occurs from the soil. Tilling often causes the soil surface to dry to the depth of tillage, resulting in the loss of $^1/_2$ to 1 inch of soil water. This dry soil must be re-wet before additional rain or irrigation water can be stored in the soil profile.

Water conservation can also be enhanced and runoff reduced or eliminated by using furrow diking. With furrow dikes, small dikes or dams are constructed at intervals along furrows or in the inter-row area between crop rows. This results in small depressions that retain potential storm runoff so it can infiltrate. Furrow dikes are applicable to dryland or irrigated crop production. The use of furrow dikes is normally recommended for use on fields that are irrigated with LEPA (low energy precision applicator) because water is applied at a high rate to a small area. When pivots are aligned up and down slope, considerable runoff can occur. Furrow diking is applicable for reduced tillage or clean tillage management but is difficult to employ with no-tillage.

Reducing or eliminating tilling reduces evaporation and increases soil water storage. The results of a 6-year dryland study of the effects of tillage on soil water contents at planting of sorghum and wheat (after 11-months of fallow) are shown in Figure 1 and Table 1. Deep chiseling with a paraplow was performed on half the field-sized watersheds, and subsequent management was with either no-tillage or stubblemulch (large V blades) dryland tillage management. Paratillage had little effect on soil water content or on grain yield with either no-tillage or stubblemulch management with either sorghum or wheat. However, compared to stubblemulch management, no-tillage management resulted in greater amounts of water in the soil contents. The soil in this study was Pullman clay loam, precipitation averaged 18 inches per year and the cropping rotation was a 3- year wheat-sorghum-fallow sequence. Paratillage was performed every third year after sorghum harvest when the soil profile was relatively dry.

No-tillage management of wheat residues prior to planting sorghum resulted in nearly an inch more stored water in the soil profile, which increased sorghum yields in comparison to stubblemulch management. Long-term research has shown that on dryland, **each inch of additional stored soil water will result in a 300-400 pound/acre increase in sorghum yield.** Wheat, however, does not respond in a similar fashion to increased soil water content at planting, because wheat yield is closely related to the timing and amount of spring rains. Thus little difference in yield results from no-tillage management of sorghum residues prior to planting wheat. Jones and Popham (1997) suggest a reduced tillage system — no-tillage of wheat residues and stubblemulch management of sorghum residues. No-tillage management of wheat residues during fallow periods increases soil water storage, increases sorghum yields and reduces erosion. Stubblemulch management of sorghum residues alleviates soil crusting and water runoff problems associated with no-tillage management of sorghum residues on clay

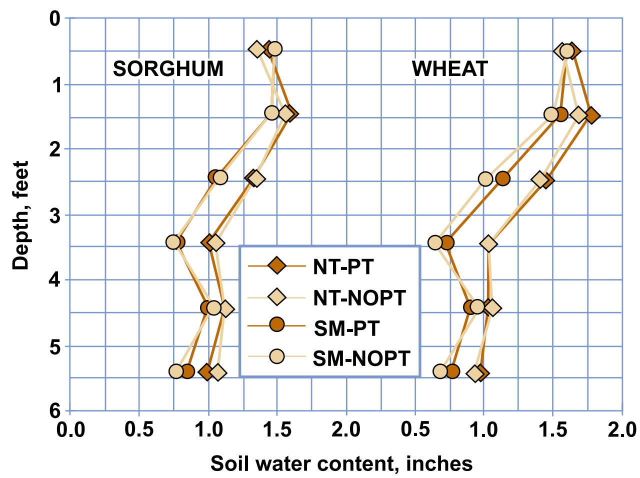


**Figure 1. Six-year (1990-1995) mean average plant available soil water contents at sorghum and wheat planting for field-sized plots cropped in a 3-year wheat-sorghum-fallow dryland rotation at Bushland, TX. A deep-chiseling paraplow treatment (PT) was applied to one-half the plots, and subsequent management was no-tillage (NT) or stubblemulch (SM). The NOPT treatment was not paraplowed but received only the NT or SM management. Fields were soil sampled (soil cores) by 1 foot increments to a 6-foot depth at planting and harvest. Every treatment was present every year.**

**Table 1. Tillage and residue management effects on 6-year (1990-1995) average soil water contents at planting and grain yields in a dryland wheat-sorghum fallow rotation — Bushland, TX**

| Treatment | Sorghum—Available soil water (inches) | Sorghum—Grain yield (bu./ac.) | Wheat—Available soil water (inches) | Wheat—Grain yield (bu./ac.) |
|---|---|---|---|---|
| NT-No PT | 7.2 | 56.5 | 7.4 | 28.5 |
| NT-PT | 7.6 | 51.3 | 7.6 | 30.2 |
| SM-No PT | 6.1 | 44.9 | 6.8 | 30.8 |
| SM-PT | 6.5 | 49.2 | 6.8 | 29.5 |

NT = no-tillage; PT = para-tillage; SM = stubblemulch soils. Alternating tillage methods will also aid in weed control, particularly with herbicide resistant weeds such as atrazine-resistant kochia.

In a 10-year dryland cropping and tillage study at Bushland, Texas, annual cropped (continuous) sorghum yields were 4 bushels/acre greater with stubblemulch tillage than with no-tillage management. Annual returns were $24/acre greater with stubblemulch, primarily due to the increased production costs of no-tillage management (Jones and Johnson, 1996).

## Recommendations

When production costs and returns are compared for a total no-tillage management system for dryland sorghum production, whether in rotation or continuous cropping, it is difficult to justify the higher herbicide costs associated with no-tillage management. Yields are not increased sufficiently to offset higher herbicide costs (Jones and Johnson, 1996).

We recommend a reduced tillage approach to sorghum production, using no-tillage for managing wheat residues prior to planting sorghum in a wheat-sorghum-fallow rotation and stubblemulch to manage sorghum residues. Weed control can be a accomplished with a combination of herbicide applications and/or tillage. To reduce in-season herbicide costs, crop rows can be banded with herbicides to control weeds. Control of inter-row weeds can be accomplished with a cultivator or with under-canopy hooded sprayer herbicide applications of glyphosate, paraquat or other chemicals.

## Conclusion

- **Weed control during cropped and non-cropped (fallow) periods is critical to successful dryland or irrigated crop production.** Weeds can use soil water at a rate exceeding 1/3 inch per day. An inch of stored soil water will increase sorghum yield by more than 300 pounds per acre. Weed control, either chemical or mechanical, is best accomplished when weeds are small.
- Tillage breaks up soil crusts, kills weeds, alleviates compaction and prepares seedbeds. However, it also **increases evaporation of soil water.** Soil will normally dry to the depth of tillage, so that 1/2 to 1 inch of water is re-quired to re-wet the tilled soil zone before additional infiltration to evaporation-resistant soil depths (2-4 feet) occurs. Stubblemulch tillage is preferable to clean tillage because crop residues left on the soil surface reduce erosion and evaporation.
- **Tillage and crop management strategies should provide a profile full of stored soil water at sorghum planting.** An additional 6-8 inches of soil water can practically guarantee a good crop of sorghum on dryland and greatly reduce irrigation pumping for irrigated sorghum production.
- **An inch of stored soil water is much more valuable than an inch of rain or irrigation water** because much of the water stored in the top foot will eventually evaporate.
- **Crop residues should be considered as another resource and should be managed as carefully as soil and water resources.** Crop residues should remain standing as long as possible to reduce wind erosion and evaporation. Not all residues are equally efficient. A ton/acre of wheat residues is much more effective in reducing evaporation and erosion than is a ton/acre of high density (larger stalks) residues such as sorghum or corn.

For more information, see the sorghum website at *http://sorghum.tamu.edu* (perform an advanced search for "tillage"). To contact individual authors, see *or-jones@tamu.edu*, *lbaumhardt@cprl.ars.usda.gov*, *pwunger@tcac.net* or *b-bean@tamu.edu*.

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